Adaptation of a Global Ocean Circulation Model to the Southern Ocean Environment

H. H. Hellmer and M. P. Schodlok

Alfred-Wegener-Institut für Polar- und Meeresforschung, Bremerhaven

Previous work

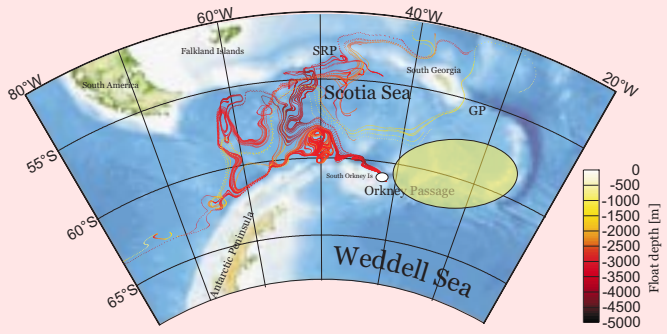


Fig. 1: Model trajectories of particles released in the bottom layer of Orkney Passage.

The **Southern Ocean** has been identified as a major drive for the global thermohaline circulation by controlling the deep branch which contributes to the ventilation of the world ocean abyss.

Processes unique to the Southern Ocean like deep convection triggered by sea ice growth, melting and freezing at deep reaching ice shelf bases, mixing at the continental shelf break, spreading of the mixing products along the continental slope, and flow across oceanic ridge systems were investigated with different versions of the regional model BRIOS.

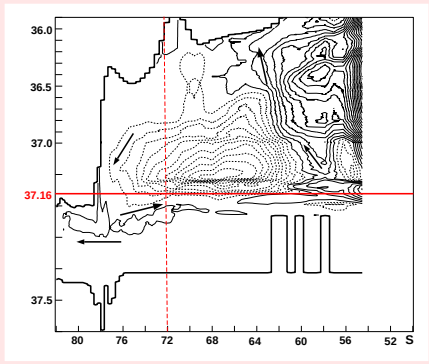


Fig. 2: Southern Ocean Meridional Overturning vss density

mass export from the Weddell Sea (Fig. 1), CFC-distribution downstream of Amery Ice Shelf, iceberg drift in the Atlantic sector, seasonal circulation under Ross Ice Shelf, sea ice drift in the Southeast Pacific, and deep und bottom water production as part of the meridional overturning (Fig. 2), to mention a few. The subjects lead to participations in international programs like DOVETAIL and AnSlope and intensive collaborations with foreign institutes (FURG, Brasil; LDGO, U.S.A.; UEA, U.K.). The figures, however, indicate that a higher resolution could capture more facets of cross-ridge flow (Fig. 1) and a global model configuration, instead of a northern boundary at 50˚S, would increase the model's capability of linking Southern Ocean processes with the global thermohaline circulation.

Benefits of a combined model :

- integration of Southern Ocean processes to global configurations
- study of global sensitivities to SO processes and inter-hemispheric feedbacks
- applicable as platform for various interests -
  bio-geochemisty (assimilate chlorophyll, carbon cycle)
  inverse modelling / data assimilation (sea ice assimilation)
- sea ice - ocean component for a couple atmosphere-ice-ocean model

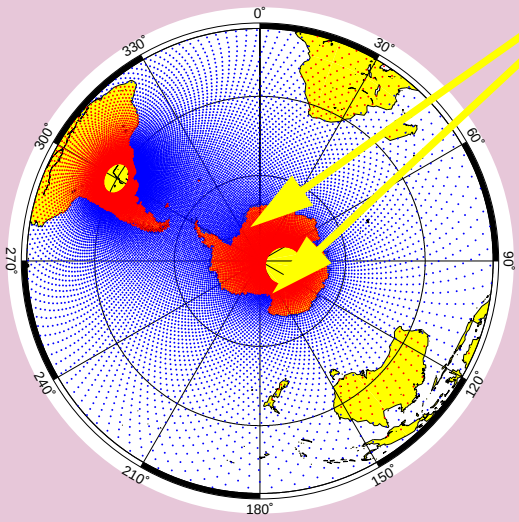
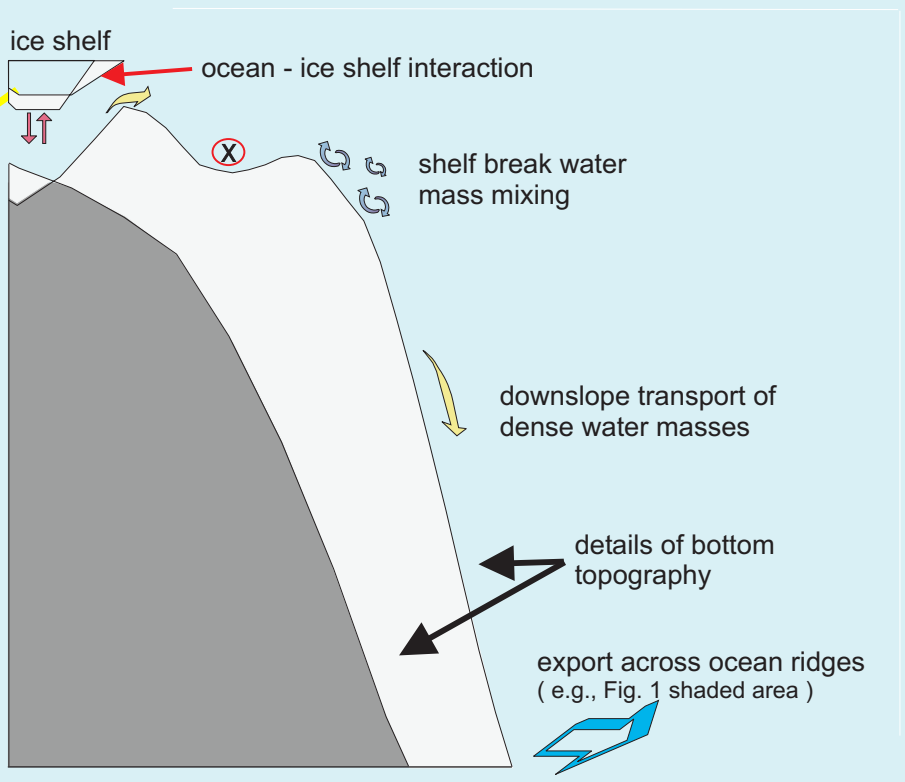


Fig. 3: Global model grid (bipolar) focused on the Southern Ocean (180 x 140 gridpoints)

Motivation



Deficiencies in BRIOS:
representation. of -

- dense water sinking near canyons and ridges
- ACC dynamics
- missing link to the global ocean
- no coupling to atmosphere model

Workload (2003/04)

During the first year, work on this project will be focused on the implementation of Southern Ocean key processes in the global coupled sea-ice ocean circulation model ORCA2/LIM

- Model modifications:
  - gradual southward decrease in grid size (~2 km at 80˚S)
  - extension of model domain towards grounding lines
  - incorporation of deep convection, ice shelf/ocean interation, water mass mixing and sinking near continental shelf break
  - optimization of BRIOS mixing schemes on NEC SX6 super computer at DKRZ
- Preparation and interpolation of data sets onto model grid:
  - merge of bottom topography from Etopo-2, AWI Bathymetry group and ice shelf data (AWI, BAS)
  - initial hydrography from Special Analysis Center (Hamburg)
  - surface forcing from ECMWF or NCAR/NCEP
- Model testing and parameter tuning:
  - validation of model results by hydrographic and ice shelf observations and by model results from previous projects of the BRIOS group

Co-operations

Various groups at AWI and PI's overseas signaled interest in the project, thus new scientific links will be established to:

- Inverse Modelling Group at AWI (Jens Schröter, Martin Losch)
- Modelle & Daten Group at MPI Hamburg (Christian Mohn)
- Carbon Cycle Group at AWI (Dieter Wolf Gladrow, Markus Schartau)
- PhyBio Physical Controls of Biological Production at AWI (Volker Strass)
- NASA USA (Stanley Jacobs, Eric Rignot)